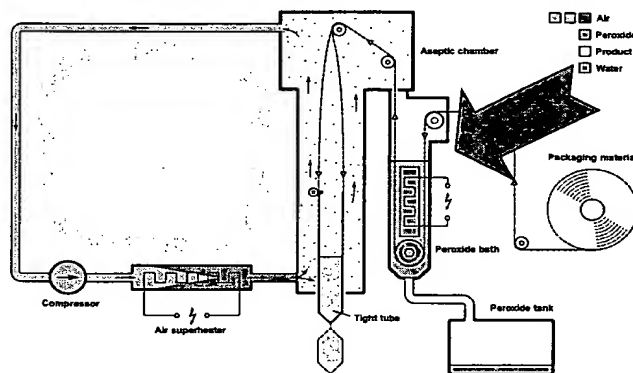


UV Irradiation to Enhance the Effect of Deep Bath of Hydrogen Peroxide for Packaging Material Sterilisation in Aseptic Packaging Machines

by Guido Moruzzi
Tetra Pak, Modena, Italy

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“Tetra Brik Aseptic” Sterile System



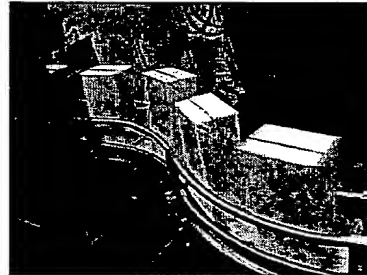
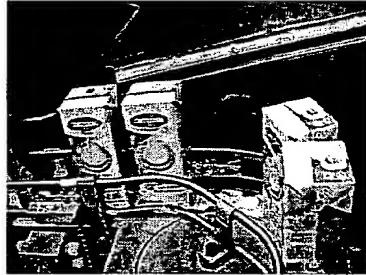
- The packaging material is sterilised by passage through a bath of H_2O_2
- Contact time, concentration and temperature are the control parameters

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Increasing the Speed of the Filling Machines

- Web Speed Increases
- Residence time in peroxide bath decreases

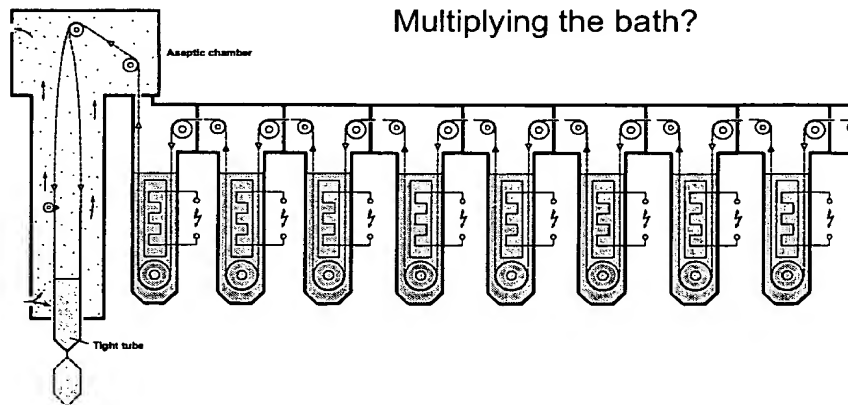


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Compensating for reduced time in the bath

Multiplying the bath?

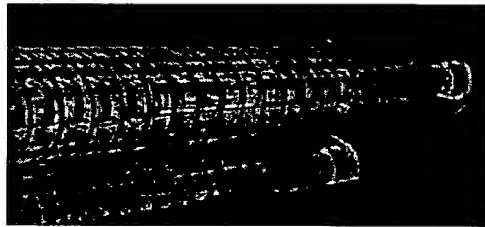


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Adding a UV lamp?

- A UV lamp
- Irradiating the packaging material
- AFTER H_2O_2 bath AND drying



So, What's Special?

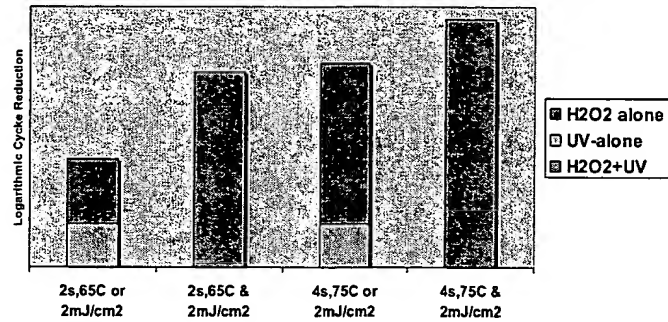
Previous art (Peel & Waites, 1980):



This concept

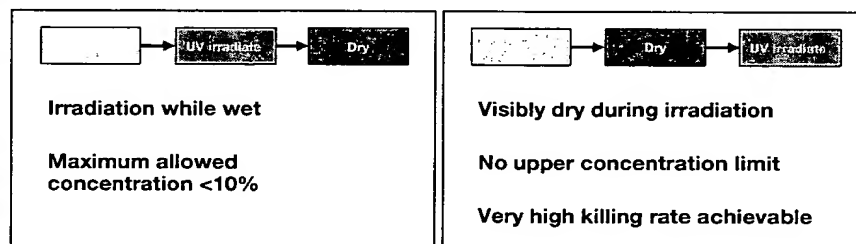


Irradiating after drying



- Results obtained on a rig – not a perfect simulation of the filling machine
- Spores of *Bacillus subtilis* A
- H₂O₂ concentration 35%
- Synergic effect clearly present

Irradiating while dry



Where is the Hydrogen Peroxide?

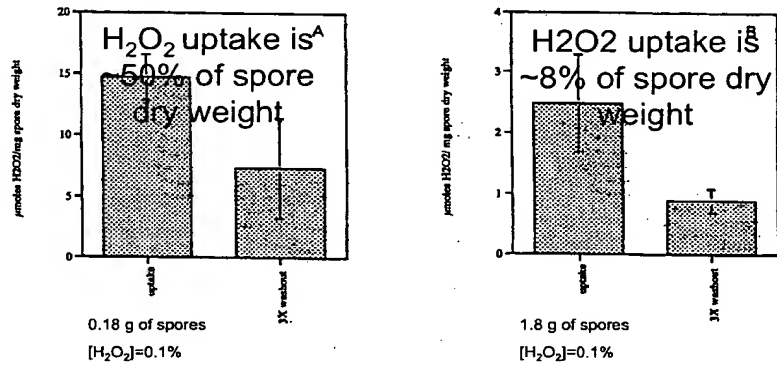
- The synergy is clearly observable
- The packaging material surface is dry
- “There must be” some hydrogen peroxide left somewhere for the synergy

Prof. R.E. Marquis, University of Rochester, NY

- Bacterial spores absorb H_2O_2 preferentially to water (“concentrative uptake”)
- The spores absorb an amount of hydrogen peroxide equal to 5 to 50% of their dry weight
- Large part of the absorbed hydrogen peroxide can be recovered by washing
- The absorbed hydrogen peroxide is “fully potent” for killing
- The absorbed hydrogen peroxide can be activated by UV irradiation even after 24 hours or more of drying

Rutherford, Reidmiller, Marquis, J. Microbiol. Meth. 42(2000), 281-290

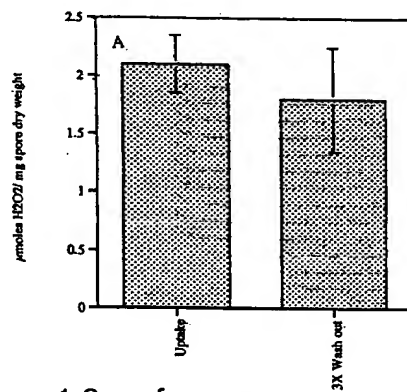
Uptake of Hydrogen Peroxide by *B. megaterium*



1/3 of absorbed H₂O₂ can be washed out in active form

Rutherford, Reidmiller, Marquis, J. Microbiol. Meth. 42(2000), 281-290

Uptake of Hydrogen Peroxide by *Cl. sporogenes*



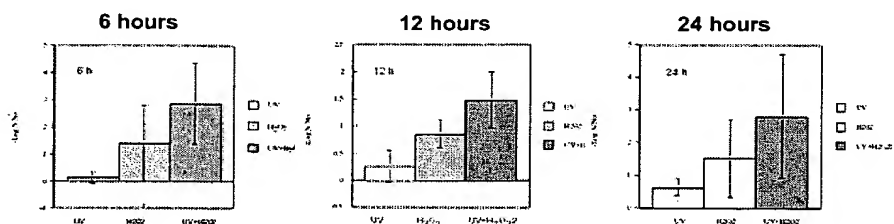
1.8 g of spores
[H₂O₂]=0.1%

- H₂O₂ uptake is ~7.5% of spore dry weight
- Nearly all absorbed peroxide can be washed out in active form

Effect of UV irradiation *Cl. sporogenes* after peroxide uptake

[H₂O₂]=0.15%

Drying at 25°C for:



The synergy between hydrogen peroxide and UV is there even after 24 hours drying

R.E. Marquis et al., unpublished

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We know what happens:

- UV activates the hydrogen peroxide in the spore body
- UV outside the spore body not useful for killing



- Irradiation while wet
- External H₂O₂ shields the UV
- Maximum allowed concentration <10%



- Visibly dry during irradiation
- No shielding
- No upper concentration limit
- Very high killing rate achievable

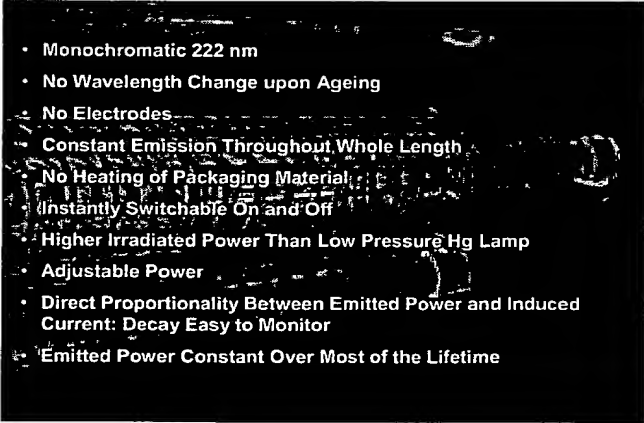
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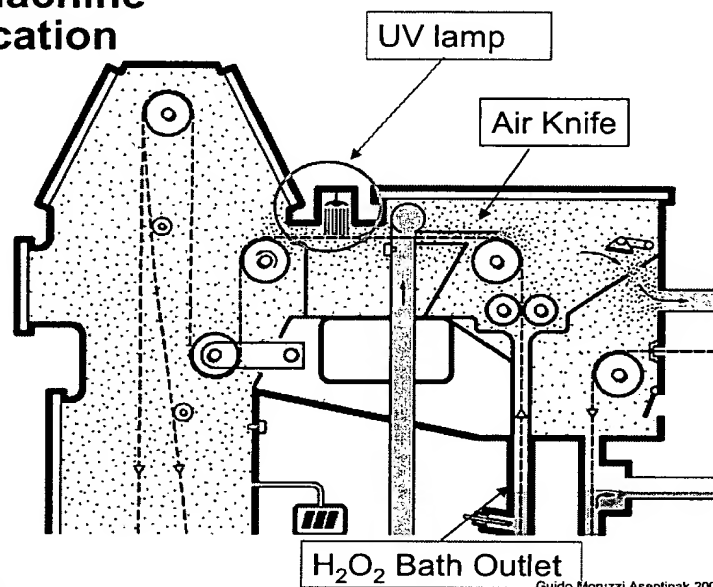
UV Lamp

- Experiments were run with UV at 222 and at 254 nm
- Wavelength (UV-C) is not critical for killing
- UV dose is critical
- Choice of UV lamp based on:
 - High intensity of emission
 - Ease of industrial operation

Excimer Lamp by Heraeus Noblelight GmbH

- 
- Monochromatic 222 nm
 - No Wavelength Change upon Ageing
 - No Electrodes
 - Constant Emission Throughout Whole Length
 - No Heating of Packaging Material
 - Instantly Switchable On and Off
 - Higher Irradiated Power Than Low Pressure Hg Lamp
 - Adjustable Power
 - Direct Proportionality Between Emitted Power and Induced Current: Decay Easy to Monitor
 - Emitted Power Constant Over Most of the Lifetime

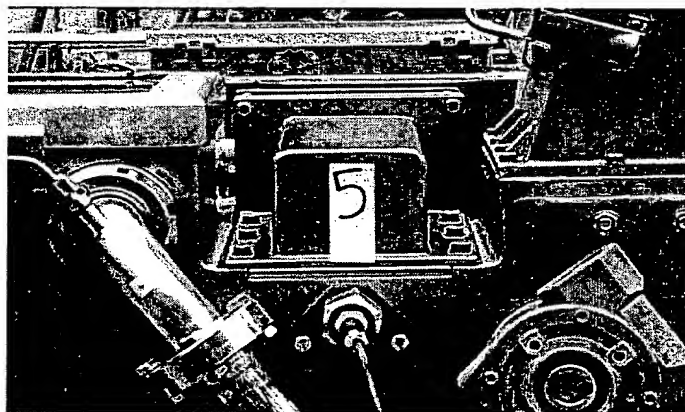
The Machine Application



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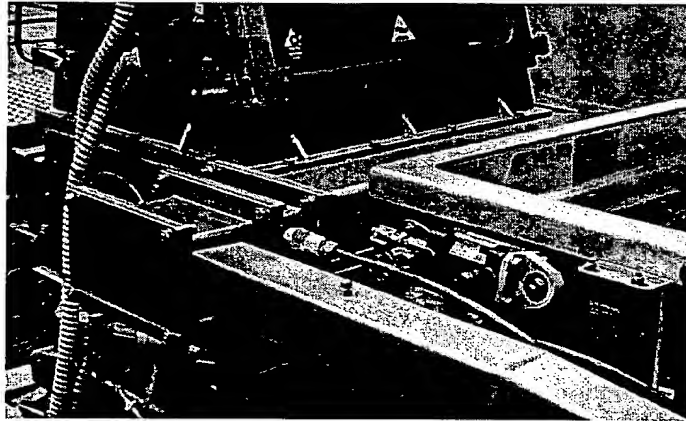
Current Machine Design



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Current Machine Design

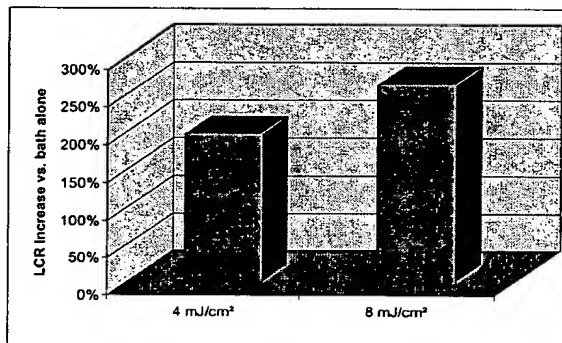


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Example of Microbiological Results (on real filling machine)

- Up to nearly 3-fold increase of bath effect
- About 1/10 sec exposure time



- Test Organism is *Bacillus subtilis A*
- Test Method:
Moruzzi, Garthright, Floros, Food Control 11 (2000) 57-66

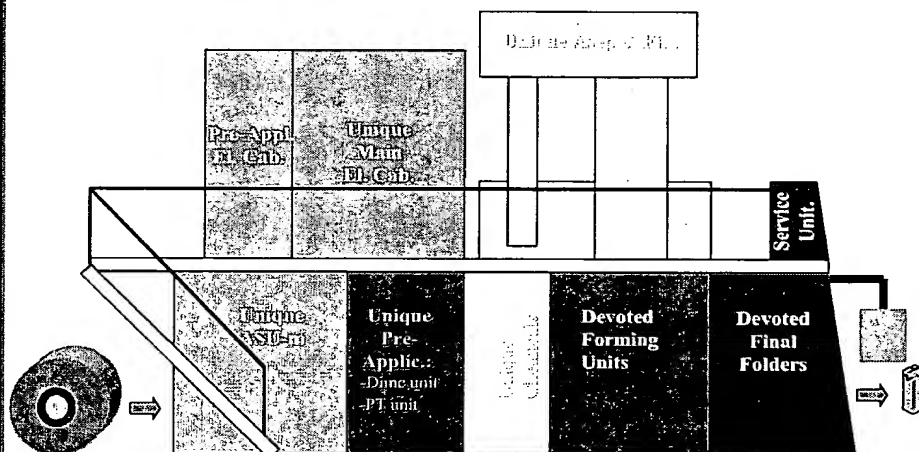
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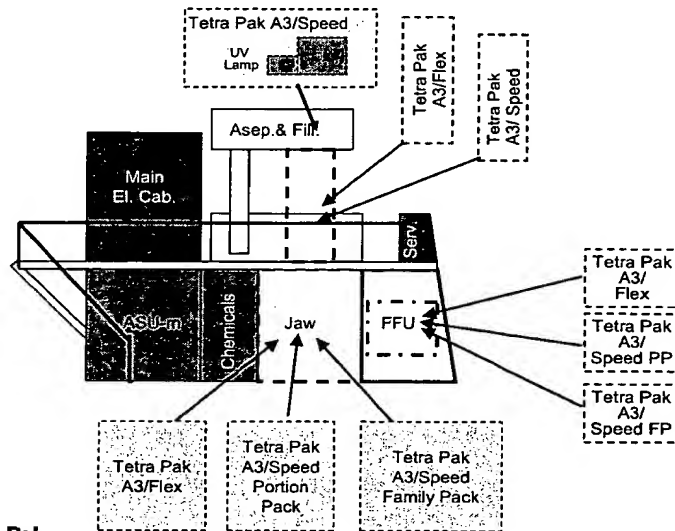
The advantage of the add-on UV-lamp sterilisation unit

- Two families of filling machines
 - “Flex”
 - “Normal” speed (7000 p/h)
 - High shape and volume flexibility
 - “Speed”
 - High speed
 - No volume flexibility
- One Platform: modular construction

Platform Modular Concept



A3 Platform Concept Flex- Speed



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